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The Siren Song of Internet Micropayments

by: Steve Crocker, Founder of CyberCash

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The Vast (?) Market for Micropayments

Would you enjoy making small payments across the Internet? Imagine paying a nickel for a stock quote, a quarter for a news article, a dollar for a picture or a song. Over the past several years, a number of Internet micropayment schemes have been invented, and some of these have been put into service. Instead of revolutionizing commerce on the Internet, the total impact has been negligible. What happened? Is the concept flawed, or were the specific efforts just not right? Is it an idea whose time has not yet come, or is it forever doomed?

I was one of the founders of CyberCash and a co-inventor of CyberCash's CyberCoin service. We had great hopes for this service. We imagined a vast market in which sellers would provide a wide array of digital goods -- music, information, pictures, games -- and customers would make small purchases over the Internet -- a page of a book, a single song, or the cost of sending in a membership. Costs over the net could be disaggregated into small components rather than bundled into larger prices. The implications for defining transaction costs and for establishing a low threshold of entry for small and low-budget vendors (like libraries, for example) were and remain potentially provocative. The approach, however, required creating new third party service to handle the financial transactions on behalf of both buyer and seller.

At CyberCash, we targeted the purchase prices to be in the range of $0.25 to $5.00. We built the system and began service in 1996 in the U.S., and later in the UK, Germany and Japan. The volume of transactions has been very low. CycberCash is suspending its CyberCoin operation in the U.S. but may revive it when there's a stronger market for it.

CyberCash was not alone in this vision of a market, and its experience is not unique. First Virtual Holdings brought out a system for small payments in 1995. That business is now gone and First Virtual has transformed itself into an entirely different business. Carnegie-Mellon University created Netbill, whose commercial rights were acquired by CyberCash. Digicash in the Netherlands pioneered a method to make payments anonymously, and put it into service in Germany and the U.S. Digicash filed for bankruptcy and has ceased operation. Digital Equipment Corporation developed its Millicent system, ran some trials and never came to market. It is possible that Compaq is reconsidering it after its acquisition of Digital, but no announcements to this effect have been made. IBM developed a system in its labs but has not brought it to market. Mastercard invested in Mondex and worked on bringing Mondex payments to the Internet. That effort stalled and has dissipated. Visa built and tested an Internet micropayment system but has also not yet brought it to market. Many more schemes have been invented and some of these have been tested in the marketplace, but none has gained a secure foothold.

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How could so many of us have gone astray? I'll draw primarily from the experience at CyberCash, but many of the issues are the same for other systems.

Why Micropayments? Why Not Just Use Credit Cards?

Credit card payments rule the Internet today. An obvious question, then, is why try to invent something new. The short answer is credit cards are unprofitable for the *seller* at purchases below $5.00.

In the U.S. last year, there were more than $900B worth of credit card transactions including face-to-face, mail order, telephone order, and Internet purchases. The average transaction was around $80. The merchant pays a fee on each transaction. This fee is divided among the merchant's bank, the cardholder's bank, the card association (Visa, Mastercard, etc.), and the various companies operating behind the scenes to process the transaction and move the data. The aggregate fee is usually between 1.5% and 3.5%, depending on the risks and costs involved. The average is about 2.2%, but Internet companies usually pay more. Merchants with large volumes of high value transactions with no complaints or chargebacks enjoy a low discount. Merchants who present a lot of risk, incur a high rate of chargebacks or whose average transaction size is low generally pay a high discount. Thus, risk itself -- always an issue in a new venture like net commerce -- increases the threshold cost. Which is precisely the problem in small payments.

Although the discount rate is usually referred to as a percentage of the transaction, often with a few cents added on as well, there's an underlying factor that is slightly less visible. From the banks' point of view, part of the cost of processing a transaction is the same for small transactions as for large transactions. The system as a whole needs to charge an average of a dollar or more for each transaction, irrespective of whether it's presented to the merchant as a percentage of the amount or a fixed amount per transaction. A large portion of this base cost covers the cardholder's bank's cost of operation -- issuing cards, setting up accounts, billing etc.

A merchant who creates a large number of very small transactions discovers his bank will raise his discount rate in order to recover its baseline costs. Hence, it is not uncommon for a merchant to refuse to accept a credit card for transactions below $5.00, $10.00, or sometimes $15.00.

The implications are clear. The transaction costs implied in the credit card financial structure mean they cannot be used directly for very small purchases. If each transaction costs the merchant a dollar just to process the credit card payment, he can hardly afford to sell anything for a quarter!

A related but no less important "cost" is the time it takes to authorize a credit card transaction. In the U.S., credit card authorizations take between 6 seconds and 90 seconds. Outside the U.S., the authorization time is often longer. A customer who makes an $80 purchase waits patiently and usually makes only a few purchases in a single day. In contrast, a customer who makes small purchases may make several in a single day and will not want to wait more than a second or two for each one. Imagine waiting 6 to 90 seconds 10 times a day in an environment that seems to promise real-time interactivity. Then, imagine waiting during periods of peak use -- at 6 p.m. the week before Christmas.

Designing a Micropayment System: Aggregation Is the Key

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Thus, micropayment systems posed several kinds of technical requirements. The ventures mentioned above all use some form of aggregation that reduces both the cost and the time delay for any single transaction. In CyberCash's CyberCoin system, the user created an account, loaded it with funds -- usually $5.00 to $20.00 -- from his checking account or credit card, and then spent against the funded amount. Each transaction involved an interaction among the user, the merchant, and the CyberCoin system, but individual transactions did not require any interaction with the banks or the credit card system.

The CyberCoin system was designed to make the purchase transaction very fast and efficient. Of particular concern was the number of messages sent between the user, merchant and CyberCoin system, the number of cryptographic operations needed to assure authenticity of the transaction, and the number of database operations needed for each transaction. We chose each of these to match what we perceived the need to be. We chose cryptographic algorithms which were strong enough to protect small value transactions but which could be carried out reasonably quickly on our computers. We reduced the number of messages sent among all the parties, and we chose a database design that allowed us to respond very quickly when a merchant forwarded an authorization from a user.

From a technical perspective, these strategies appear to have been effective. When the system operates at high volumes, the cost of an individual transaction is low, perhaps a fraction of a cent. Further, the system adds only about a second to the total transaction time.

Assured Delivery Reduces Customer Service Cost

Another source of expense in any payment system is the cost of handling complaints and questions from the consumers. A customer service operation requires many people, telephones, and computers. Customers are usually confused or irritated, so the interactions are far from efficient. Each customer service call costs a few dollars, sometimes more. If there is no way to resolve a dispute amicably and quickly, there might be several calls associated with the same transaction.

Customer service becomes a serious burden in the micropayment world. Even if the nominal profit margin is high on individual micropayment, the absolute margins are rather thin. A single customer service call can easily wipe out an entire year's profit on that customer account. And an unhappy customer can put a dent in company's profitability. Therefore, one of the design goals in each of the micropayment systems was a reduction in the number of customer service calls.

One potential source of dispute in online transactions is that the customer may claim he did not receive the digital goods he paid for. Several micropayment systems included some form of "assured delivery," approximately equivalent to the U.S. Postal Service's certified delivery service. To assure delivery, the payment process is intertwined with the delivery of the digital goods. For example in the CyberCoin and Netbill systems, encryption is used to assure delivery.

When the user requests the information, perhaps a page from Gray's Anatomy for a medical student who needs it for a paper, the "goods" are sent back to the user's system in an encrypted form before the user pays. This puts the information on the user's computer but does so in a form the user cannot read.

Once the encrypted information is on the user's computer, the user's system sends back an authorization for payment, and the merchant's system forwards this authorization to the clearing center. The merchant's system also includes the key necessary for

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decrypting the digital goods. The clearing center debits the user's account and credits the merchant's account. When the merchant's system receives acknowledgement from the clearing center that payment is complete, the merchant's system forwards the key to the user. The user's system then decrypts the digital goods and displays or stores the result.

If the merchant's system fails to deliver the decryption key to the user's system, the user can contact the clearing center to obtain the key. The user's system maintains a copy of recent transactions, so it can prove that it received the encrypted information and that it authorized payment. This information is sufficient to show that the user paid for the goods and is entitled to decrypt them, thus providing protection from failures in the merchant's system or potential fraud by the merchant.

How well does this scheme work to reduce customer service costs? No one knows. There has not been enough volume in any of the micropayment systems to gauge how large customer service costs are or whether assured delivery is an important way to reduce those costs.

What Went Wrong?

As noted in the introduction, neither the CyberCoin system nor any of its competitors has made much progress in the market. What went wrong? We know some of the reasons, which I list below. But far more important is what we do not know. I am convinced that it is not sufficient to simply fix the problems we know about.

Too much authentication

The early micropayment systems were clumsy to use, mostly because the designs erred on the side of caution. In the early implementations of CyberCash's CyberCoin system, the user was presented with multiple screens for each transaction. This level of caution is appropriate for higher value purchases, but it slowed down the interaction. The user did not find it a compelling or gratifying experience.

A more onerous hurdle was the loading of the user's account. In the CyberCoin system, we experimented with two forms of payment, checking accounts and credit cards. The credit card payment was fairly easy, but many users were, nonetheless, reluctant to pre-pay $20.00 to load their CyberCoin accounts. Payment from a checking account was significantly worse. Before we could give users access to their checking account online, we required a canceled check and other proof of identity by mail. Very few people went to the trouble of setting up a CyberCoin account tied to their checking account.

Later, these barriers were lowered. The payment process was streamlined. In other systems, a user was permitted to accumulate charges first and then have them charged against his credit card. These were a big improvement, but they didn't prove sufficient.

Too few merchants

As with all network systems, a critical mass of users, sellers as well as buyers, is required. Bob Metcalfe suggested the value of a network grows as the square of the number of users. All of the early micropayment systems failed to gain a critical mass of merchants

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and a critical mass of consumers. These two groups reinforce each other, of course. In all of the early ventures into micropayments, there was neither a single compelling digital good available only through the micropayment system nor an overwhelmingly attractive variety of digital goods.

An Internet micropayment system might yet come into widespread use if pushed by a large marketing power. We can imagine that AOL, Visa, Mastercard, or a collection of large banks might have sufficient marketing power to entice a substantial number of merchants to come into the market and make their digital goods available in small transactions. On the other hand, this may be exactly backwards. The banks or other financial services companies are more likely to provide a successful micropayment system when the merchants demand it. Perhaps the critical mass needs to come from a collection of large publishers who view micropayments as essential for their growth and health.

Subscriptions and Advertising -- Alternatives to Micropayments

Once upon a time we thought micropayments were the only way merchants would deliver small quantities of digital goods. However, two very important alternatives emerged: subscriptions and advertising. Both of these have substantial advantages from a merchant's point of view.

Subscriptions provide guaranteed income. If a merchant were to choose between selling digital goods on a one shot basis and selling on a subscription basis, the merchant will choose subscriptions. Although the higher price for a subscription will mean that some of the potential buyers will be lost, it also means that a higher price will be extracted from a number of buyers. Moreover, the guaranteed income gives the merchant much greater ability to plan, provision and grow.

Subscriptions have another and perhaps even more important quality. They provide considerable information about the consumer and establish a relationship between the consumer and the merchant. Consumer information is extremely valuable in its own right, as it enables to the merchant to target further sales pitches more accurately -- "up-selling" and "cross-selling" -- or to sell this demographic information to others for similar purposes. The relationship also generates renewals, thereby continuing the income stream in future years.

Compared to subscriptions, selling individual items on a one-shot basis is a secondary concern. Micropayments are useful as a way to draw in new customers and to serve casual customers who will not pay for subscriptions, but it's unlikely to be preferable to subscriptions.

Advertising, too, has been an extremely successful alternative for funding the delivery of small digital goods. Stock quotes and news stories, in particular, are easily available on the web free of direct charge. Web searches are also free, though they cost the search companies quite a lot of money to provide. Instead of a few cents for each transaction, the users pay attention. That attention may be far more valuable to the merchant and his advertisers than the few cents the merchant might collect. In this respect, the web is similar to broadcast television.

Reverse Micropayments, The Internet Surprise

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All of the early micropayment systems were aimed at collecting small amounts of money from large numbers of consumers in exchange for digital goods of (presumably) real value from a relatively fewer number of merchants. As described, none of these has achieved any large volume.

An interesting reversal seems to have occurred, however. Several companies, Cybergold, Netcentives and ClickRewards among them, have been making small payments to consumers instead of collecting small payments from them. These payments are either for attention to ads (Cybergold) or rewards for patronage (Netcentives and ClickRewards). Compared to the several micropayment systems, each of these "reverse micropayment" systems is overwhelmingly successful.

Cybergold is a particularly interesting case study. It offers users anywhere from fifty cents to five dollars to read an ad. Users have to register and describe themselves. The payment varies according to the material and the demographics of the user. An ad for a Cadillac will be worth far less to a college student than to a middle-aged, high income executive. Cybergold reports that it has hundreds of thousands of users and has accumulated around a million dollars in payments, most of which is sitting in its accounts waiting to be disbursed to the users or consumed in some fashion. In an effort to provide additional outlets for its users to use the funds they have accumulated, Cybergold is now entering the classical micropayment business. It remains be to seen whether it reaches critical mass and creates a sustainable system.

That reverse payments may prove the first commercial success of the micropayment model should not surprise me. The trajectory of the Internet has surprised us all, even those of us who worked on it when it was an experimental system among a relatively small group of researchers. That it may transform the way we work and our economic structures is likely. What we have learned from micropayments is that new technologies do not change people and organizations overnight, that change is hard, and that the future holds many surprises.

Steve Crocker was one of the founders of CyberCash and a co-inventor of CyberCash's CyberCoin service. In the late 1960's and early 1970's, Dr. Crocker was part of the team which developed the protocols for the Arpanet and laid the foundation for today's Internet. In addition to his technical work, he organized the Network Working Group, the forerunner of the modern Internet Engineering Task Force, and initiated the Request for Comment (RFC) series of notes through which protocol designs are documented and shared. Steve Crocker Associates, LLC is a consulting and R&D company specializing in current Internet and electronic commerce technologies.

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